Prepared Statement of
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on
"Climate Change:
Lessons Learned from Existing Cap and Trade Programs"
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Mr. Chairman and Members of the Committee:

Thank you for your invitation to participate in today's hearing. I am Anne Smith, and I am a Vice President of CRA International. Starting with my Ph.D. thesis in economics at Stanford University, I have spent the past twenty-five years assessing the most cost-effective ways to design policies for managing environmental risks, including cap-and-trade systems. For the past fifteen years I have focused my attention on the design of policies to address climate change risks, with a particular interest in the implications of different ways of implementing greenhouse gas (GHG) emissions trading programs. I thank you for the opportunity to share my findings and climate policy design insights with you. My written and oral testimonies reflect my own research and opinions, and do not represent any positions of my company, CRA International.

The topic of today's hearing is to review the experience with existing (and past) cap-and-trade programs, and to determine what lessons these experiences provide for effective design of a possible U.S. GHG cap-and-trade program. The most fundamental point that I would like to make is that cap-and-trade should not be treated as an off-the-shelf technique.[1] It can be extremely effective at delivering efficient emissions reductions for any type of emission, but to do so, it must be tailored to fit the particular features and complexities of each emissions problem. Direct and unquestioning adoption of the cap and trade design used in any previously successful cap-and-trade program is likely to sow the seeds of failure in a new application, such as greenhouse gases. The SO_2 program under Title IV of the Clean Air Act has clearly been a success, but some of the most widely recognized features of that program are not desirable features of a cap-and-trade policy tailored to address the much greater complexity of greenhouse gases.

Therefore, in my testimony I will describe the specific challenges and complexities that a GHG cap-and-trade policy needs to address, and offer suggestions for how these issues can

[1] I have made a more complete exposition of this point in A. E. Smith, "The Challenges Ahead for Emissions Trading Programs: Nitrogen Oxides and Greenhouse Gases," report prepared for Edison Electric Institute (CRA No. 1656-00), March 1999.

best be addressed through the design of such a program. In doing this, I will relevant "lessons" to be found in existing and previous cap-and-trade programs, as well as the contrasts.

KEY DESIGN CHALLENGES FOR GHG CAP AND TRADE

There are three key issues that make a GHG cap-and-trade program significantly different from the U.S. SO_2 program: (A) the multiplicity of types of sources of GHGs, (B) potential economic impacts of carbon permit price uncertainty and volatility, and (C) international competitiveness implications of a GHG cap. If these issues are to be effectively addressed, a GHG cap-and-trade program will be very different in its design from the SO_2 cap-and-trade.

A. Multiplicity of Types of Sources.

GHGs include not just CO_2, but also such diverse compounds as nitrous oxide, hydrofluorocarbons, methane, and sulfur hexafluoride. These all come from very different types of economic activities, ranging from industry to agriculture. CO_2 emissions mainly result from the burning of coal, natural gas, gasoline and other petroleum products to extract the energy from these fuels. This is done not just by large industrial sources, but by hundreds of millions of individual commercial entities, households, and automobile driving. In fact, large industrial sources of CO_2 account for only about half of all CO_2 emissions, and a cap on these emitters alone would encompass tens to hundreds of thousands of sources. (For example the EU ETS, which is not known for offering comprehensive coverage of emissions, includes over 10,000 sources.) Higher coverage of the emissions that need to be reduced is simply administratively infeasible with a cap-and-trade program, as it would require monitoring of individual tailpipes and end-user appliances in homes and businesses.

There are two ways of responding to this dilemma:

1. The most common suggestion is to accept that the cap-and-trade program's coverage will be severely limited and to start to regulate all of the other, smaller sources with technology standards, regulatory mandates, and other forms of command-and-control regulations that emissions trading is supposed to outperform. This is the path that the EU ETS has taken. While emissions under the EU ETS cap may be held in check successfully, the majority of the EU emissions remain uncapped and continue to grow unchecked. These emissions are the real reason that the EU continues to risk failing to meet its Kyoto Protocol targets. Even if outright failure to achieve national GHG targets were unimportant, the inefficiency of this approach is a serious concern.

   I have performed a number of cost modeling exercises to compare this kind of approach to the ideal of a single comprehensive cap over all emissions sources, large and small. In my modeling study, I first estimated the cost of meeting a U.S. GHG target with a cap that offered 100% coverage. I then considered what it would cost to meet the same emissions target by capping all sources large and small except for personal automobile use. The latter category was instead placed under a more stringent fuel economy standard (e.g., a tighter CAFE standard). This second approach was estimated to be 50% to 155% more costly than the idealized cap-and-trade program over a range of reasonable alternative possible fuel economy standards.[2] Subjecting more of the many small emissions sources in addition to personal automobiles to regulation outside of the comprehensive cap-and-trade program would only further increase the total costs. The report of the Energy Information Administration on the costs of the 2005 "Bingaman Amendment" (which contained a provision for a CAFE standard as well as a GHG cap) similarly found that the CAFE provision was a very costly way of achieving larger emissions reductions than under a cap.[3]

2. An alternative suggestion is not to impose the cap on emitters, but rather to impose it on sellers of fuels that, when burned, will cause CO_2 emissions. This is sometimes called an "upstream" cap-and-trade approach because the point of regulation occurs on economic activities that occur before, or "upstream of," the economic activity that burns the fuel and produces the actual emissions. (Similarly, caps applied at the point-of-emission are often called "downstream" approaches.) I, and other analysts after me, have pointed out that this approach will allow for nearly 100% coverage of CO_2 emissions with fewer than about 10,000 regulated companies.[4] This means that an upstream system offers a nearly ideal freedom from the inefficiencies of technology mandates and other non-market forms of regulation within the bounds of administrative feasibility.

   The upstream approach can also be applied to some of the other non-CO_2 GHGs, including sulfur hexafluoride and HFCs, thus minimizing the need to monitor the actual emissions of these gases as well (which also come from many very small sources, such as electrical transformers and refrigerators). Finally, an upstream approach for the former sources can be seamlessly combined with a "downstream" point of regulation for those GHG sources that cannot be anticipated in an upstream product sale. Thus, emissions of nitrous oxides and methane can still be capped just as effectively under an upstream approach as under a system that regulates solely at the point-of-emission.

Most economists studying efficient designs for cap-and-trade program concluded many years ago that the upstream approach is the most appropriate design for the GHG

[2] E. J. Balistreri, P. M. Bernstein, et al., Analysis of the Reduction of Carbon Emissions through Tradeable Permits or Technology Standards in a CGE Framework," AERE/Harvard Workshop on Market-Based Instruments for Environmental Protection, Harvard University, Cambridge, MA, July 18-20, 1999.
[3] EIA, *Impacts of Modeled Recommendations of the National Commission on Energy Policy,* SR/OIAF/2005-02, April 2005.
[4] A. E. Smith, A. R. Gjerde, et al., "CO_2 Trading Issues: Choosing the Market Level for Trading," Final report prepared for Office of Policy, Planning and Evaluation, U.S. Environmental Protection Agency, under Contract No, 68-CO-0021, May 1992.

application.[5] Throughout the 1990s, the upstream approach was widely dismissed as not politically acceptable because its effect would be to place an explicit price of carbon on the cost of fuels. However, the impossibility of constructing a realistic cap proposal that provided meaningful coverage of the emissions of concern eventually became clear. The McCain-Lieberman Bills of 2003 and 2005 addressed vehicle emissions by capping the carbon content of gasoline sales. A pure upstream approach was central to the National Commission on Energy Policy's proposal, and also was incorporated into Senator Bingaman's 2005 and 2007 draft Bills. Despite resistance to the upstream approach in the GHG policy debate, it is noteworthy that the upstream approach is not at all untested in past programs. In fact, two of the first emissions reduction programs that used cap-and-trade methods were upstream. These were the programs prior to 1990 to phase lead out of gasoline, and to phase-out chlorofluorocarbons under the Montreal Protocol. Both programs to limit emissions were applied to the point-of-sale rather than the point-of-emissions. In both cases this was done because it would have been administratively impossible to regulate the many small sources of emissions, yet it was just as effective in meeting emissions goals to regulate the sales of the product that would eventually result in emissions. The exact same situation applies to CO_2 and other GHGs, and thus the same type of design of the cap-and-trade program makes sense.

The only thing that has changed since the time the upstream approach was originally (and successfully) used is that the SO_2 cap-and-trade program was introduced, riding on the coat tails of the successes of the earlier lead-in-gasoline and CFC trading programs. The SO_2 cap could *not* have been implemented as an upstream program, but only at the point-of-emission, simply because one of the key forms of emission reduction was a post-combustion control technology. At the same time, it was quite administratively feasible to monitor emissions at sources and still achieve very high levels of coverage. The situation was different, and so a point-of-emissions ("downstream") approach was applied for SO_2. The earlier successes using an upstream approach were not held up as reasons to avoid using a downstream approach for SO_2; in turn, it makes no sense to claim that recent successes with a downstream approach for SO_2 (and NO_x) are reasons to avoid using an upstream approach for GHGs. Cap-and-trade should not be used as an "off-the-shelf" panacea: it must be tailored to the particular features of each particular emissions reduction need. In seeking "lessons" for GHGs from past policy experience, we should recognize that this experience did not begin only in 1990 with the Title IV SO_2 cap, but to look at the full history with market-based tools, dating back to the 1970s. When we do that, it becomes clear that the case for an upstream approach to a GHG cap is just common sense and not radical or even novel.

Despite the growing recognition of the strong case for capping GHGs using an upstream approach, concerns about how the point of regulation may affect each company's allocation of emissions still generates some resistance to the upstream approach. This is due to a common, but mistaken, belief that allocations should be made to the parties that are regulated, and not to any of the unregulated parties. Under past cap and trade programs, allocations have always been made this way. However, allocations of permits under a cap

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[5] For example, the upstream approach was a central feature of a policy proposal by researchers at Resources for the Future in 1999.

may be made according to any of a very wide range of formulas, yet have no effect on the efficiency or functioning of the market. Further, there is no sound reason to expect that allocations to the regulated party are somehow "more fair." In fact, the financial impacts under any cap on GHGs (a widely accepted notion regarding who should receive valuable allocations) are more likely to be concentrated on fuel producers and transporters than on downstream parties. This is because the primary forms of CO_2 control at low to moderate carbon prices involve fuel switching. A cap on emitters may cause them to switch the fuels they use while continuing to supply their customers with their own product–effectively passing most of the burden of their cap back to fossil fuel suppliers. We can and should clearly separate the decision about the point of compliance from any decisions on who should receive free permit allocations. Until this misunderstanding is eliminated, it will only stand in the way of designing an efficient and effective cap-and-trade program suitable for GHGs. The fact that allocations were given solely to companies at the point of regulation in the existing and past cap-and-trade programs should *not* be considered a "lesson learned" from any past experience, but only a political convenience that has not yet been sufficiently challenged by other parties whose financial fortunes were likely to be affected by the imposition of the cap.

B. Potential Economic Impacts of Carbon Permit Price Uncertainty and Volatility.

Prices in all previous and existing permits have exhibited substantial volatility, and this can be expected of GHGs as well.[6] Price volatility, however, is likely to have much greater generalized economic impacts with a CO_2 cap than for caps on SO_2 and NO_x. CO_2 is a chemical that is an essential product during the extraction of energy from any fossil fuel. As long as fossil fuels are a key element of our energy system (which they are now, and will remain for many years even under very stringent caps), any change in the price placed on GHG emissions will alter the cost of doing business throughout the economy. This is because all parts of the economy require use of energy to one degree or another.

In contrast, under the Title IV SO_2 cap, a fluctuating SO_2 permit price would only affect emissions from coal-fired electricity generation. In deregulated electricity markets, coal-fired electricity does not always affect the wholesale price of electricity, and even significant fluctuations in SO_2 permit prices might have almost no effect on electricity prices. Even in regulated electricity markets, the impact of the SO_2 price on the cost of all electricity generation would be diluted by the unaffected costs of all other sources of generation before it reached customers. Also in contrast to an economy-wide GHG cap, no other sources of energy in the economy are affected at all by SO_2 price changes. Finally, under the Title IV SO_2 cap, price variations during the past year that range from $400/ton to $1500/ton (the range observed in the past year under Title IV) have a modest effect on

[6] Some have argued that banking reduces price volatility. While it may reduce it, it certainly does not eliminate it. For example, the Title IV SO_2 market has experienced high volatility over the past two years, even though it has a large bank already in place. During 2005, SO_2 permit prices rose from about $600/ton to above $1600/ton, then plummeted to below $400/ton by the beginning of 2007. Additionally, banking offers little price stability at all during the start up of a new cap, simply because no bank yet exists, and this initial-period volatility can be very large if the first-period cap requires a substantial amount of reduction and/or has a relatively brief regulatory lead time. The experience of the first year in the NO_x cap of the Ozone Transport Region of the northeastern U.S. is a classic example.

the majority of coal-fired units that are already either scrubbed or burning low-sulfur coal. Such units might see the cost adder due to its SO_2 emissions vary between 7% and 26% of its base operating cost,[7] and (as noted) the impact on consumer's cost of electricity would be much smaller, if anything.

Variation of CO_2 prices such as that observed in the EU ETS market over the past two years (approximately $2/ton to $35/ton) would cause *all* coal-fired units to see additional costs varying between about 10% and 175% of their base operating costs. Further, even gas-fired units would experience absolute cost increases equal to about half those of the coal-fired units.[8] Since gas-fired units do frequently set the wholesale market price of electricity, consumer electricity prices would also vary markedly with the price of GHG permits. Retrofits would not be available to attenuate these costs (at least, not until even higher permit price levels would be achieved and *sustained* at those levels.) At the same time, all other key energy demands in the economy (e.g., for transportation, industrial process heat, building heating and air conditioning, etc.) would also experience similar fluctuations with varying GHG permit prices. Clearly, the effect on the economy could be disruptive.

These are not just theoretical calculations. The EU's statistics bureau, Eurostat, reports that electricity prices rose significantly throughout the EU in 2005. Household rates rose by 5% *on average* over all 25 EU countries, and industrial rates rose by 16% on average.[9] The high prices of GHG permits under the EU ETS during that period is widely viewed as having contributed to this price increase, and indeed, wholesale electricity prices have fluctuated in step with the wide swings in ETS permit prices. It is not clear yet how or whether the wide variations in permit prices may begin to contribute to the variation in economic activity. However, it should also be noted that the EU ETS does not cover all sources of GHGs, or even a majority of sources of CO_2 emissions in the EU. (This may dampen the impacts of CO_2 permit price volatility on the EU economy, but is also a widely observed flaw in that cap-and-trade system's potential to produce sufficient cuts in GHG emissions necessary for the EU to meet its GHG targets.)

To sum up, price uncertainty and price volatility will impose impacts in the case of GHG emissions limits that are completely different in scale and scope from those under previous emissions trading programs. Their potential to increase variability in overall economic activity thus should be viewed as a core concern in designing a GHG cap-and-trade program. At the same time, the nature of climate change risks associated with GHG emissions is such that it is possible to design price-stability into a GHG cap-and-trade program without undermining its environmental effectiveness. In the case of a stock pollutant such as greenhouse gases, there is no need to absorb high costs in return for great

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[7] By "base" operating cost, I mean the cost of generating a unit of electricity before accounting for the emissions price. The majority of this cost is the cost of the fuel.
[8] However, the percentage increase in the base operating cost would be much smaller (i.e., about 30% compared to 175%) because natural gas is so much more expensive than coal.
[9] Eurostat, "News Release – July 14, 2006" (Revised version 93/2006), available at http:/ec.europa.eu/eurostat

specificity in achieving each year's emissions cap.[10] Economists widely agree that the cost to businesses of managing the price uncertainty of a hard cap is not worth the greater certainty on what greenhouse gas emissions will be from year to year.

There are various ways to provide much greater price certainty under a cap-and-trade program, although none have been used in any trading programs to date. One of the simplest concepts that has gained substantial attention for GHGs has been called a "safety valve." Unfortunately, this term has begun to be used loosely (e.g., under the rules of the Regional Greenhouse Gas Initiative, and in California's AB32 program) for a variety of mechanisms that do not actually provide the price certainty originally intended. To be quite specific, the cap-and-trade program mechanism that provides the requisite price cap is one where the government offers to issue any number of additional permits to regulated companies at a pre-specified and fixed price per permit. This price is set low enough that it is not considered punitive, but rather as an assurance by the government that it would not consider control costs above that level to be desirable as a normal course of events.[11] This is the mechanism that has been incorporated into the draft bill of Senator Bingaman.

Because regulated entities know that they need not ever pay more for a permit than the established safety valve price, it functions as a price ceiling. No company would ever pay more to purchase a regular permit in the emissions market if it knows that it can always obtain sufficient permits at that price from the government, if necessary. Permit prices may fluctuate at levels below the safety valve price, but by judicious selection of an appropriate safety valve price, policy makers can ensure that these variations would not rise to a level that might be viewed as potentially harmful to the economy at large. If the safety valve price is hit on an occasional basis under a cap, then the goal of achieving long-term reductions in emissions is not harmed, given that the primary environmental risk of GHG emissions is a long-term, cumulative one. If the safety valve price is hit on a perpetual basis, this suggests an important need for policy makers to consider how we should address the evidence that meeting targets that are more difficult than hoped; however, this policy deliberation will be possible without the urgent need to throw "band-aid" solutions onto the cap-and-trade program, and with concrete evidence of the degree of economic pain that is associated with the initially-established maximum permit price. A higher price might then be deemed acceptable, but if not, the safety valve will have helped us avoid the greater pain of learning that fact through a hard cap approach.

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[10] Richard G. Newell and William A. Pizer 2003, "Regulating Stock Externalities Under Uncertainty," *Journal of Environmental Economics and Management,* Vol. 45, pp. 416-432.

[11] Outside of the U.S., further confusion about the notion of a "safety valve" has been created by application of this term to the traditional notion of a penalty for noncompliance. The EU ETS has a penalty for noncompliance that is €40/ton CO_2 in Phase I and will be €100/ton in Phase II, starting in 2008. This is often described as a price cap, but its very high level relative to the price at which the cap is expected to be met makes it extremely ineffective. Further, its role as a penalty rather than as an additional compliance mechanism clearly would undermine the willingness of companies to resort to its use for planning purposes. The same confusion of penalty and safety valve appeared in the proposal for an Australian emissions trading scheme released in 2007 by Australia's National Emissions Trading Taskforce. The notion of a "safety valve" should be clearly separated from the role of a noncompliance penalty, with the former being set at a price that is considered an acceptable level of policy implementation cost, and the latter being set at a much higher level that is considered "punitive" and not acceptable as an indicator of the cost of meeting the policy goals.

Some researchers also have spoken of creating price floors along with price ceilings as part of a cap-and-trade system for GHGs. This would certainly offer even greater price certainty, with attending benefits. It can be done by creating a direct rule by which the government (or an authorized entity that would act like a "central banker" for the permit market) would buy back permits if prices fall below a particular level (or to reduce the number of permits available through auction). All of these proposals, however, point to the fact that the truly appropriate market-based mechanism to address climate change risks, which accepts the long-run, cumulative nature of this risk is an emissions price-setting approach, not an approach that limits emissions to ad hoc but rigidly defined levels, which is the fundamental feature of a pure cap-and-trade program. Once one accepts this notion, policy development attention can shift to the question of what that carbon price level should be, and impose it directly as a carbon tax. This would be far simpler for government to administer, and far less subject to *ex post* manipulation or unintended consequences than any cap-and-trade program with a complex set of price-controlling features.

C. International Dimension.

It is thus a quite manageable task to design a cap-and-trade program to address the great multiplicity of domestic sources of GHG emissions – the only challenge in doing so is to overcome the widespread but erroneous notion that any effective cap must be imposed at the point-of-emission. It is an equally manageable task to design a cap-and-trade program to mitigate the most severe effects of price uncertainty and price volatility – the only challenge is in embracing the fact emissions targets for GHGs need not be rigidly achieved in each individual time period of a program that will strive over multiple decades toward an ultimate goal of near-zero emissions. However, it is a far more difficult challenge to manage the complexities created by the international dimension of GHGs and climate change through design of a domestic cap-and-trade program.

As noted above, the cumulative manner in which GHGs affect climate change risks gives us flexibility to modify our emissions targets in individual periods in order to manage costs. Similarly, this cumulative manner implies that emissions from any part of the globe have comparable impacts on climate risks, as they all first accumulate together in the global atmosphere to have their combined and joint effect on the global greenhouse effect. On the one hand, this offers important flexibility to reduce emissions anywhere in the globe that has cost-effective opportunities to do so, and not to confine domestic efforts to actions within US borders. On the other hand, it also means that any GHG cap we impose domestically, and its attending domestic reductions, may be undermined by offsetting increases in nations that do not have comparable caps on their own economies. Large sums of money could be spent with no actual global environmental benefit.

This latter adverse possibility is made a real concern by the point I made in Section B above that setting a price on CO_2 emissions will inevitably create a widespread increase in the costs of production throughout the entire economy, because it will affect the cost of all the basic forms of energy services that are essential to nearly all economic activities. As domestic costs of production rise under a GHG cap-and-trade program, our economy loses some of it competitive edge to countries not undertaking similar emissions control efforts. Unfortunately, the loss of competitive edge will tend to be greatest in those industries that produce the largest domestic CO_2 emissions, and so some of those highly-emitting productive activities will be offset by increases in the same activities abroad. Domestic emissions may fall to meet the domestic cap, but global emissions will not fall as much.

The higher the price of permits under the domestic cap, the more serious this "leakage" is likely to be. Thus, the international dimension of GHG emissions provides an important additional reason for directly managing the price of permits that may occur under a domestic GHG cap-and-trade program to a relatively low level. This relationship between higher permit prices and increasingly ineffective environmental outcomes has not been a concern for any previous cap-and-trade program addressing emissions such as SO_2, NOx, volatile organics, or particulate matter. It is not even a concern for the coming US cap on utility mercury emissions, even though mercury emissions are much more of a global issue like GHGs.[12]

The only way to design a domestic cap-and-trade program to address this international competitiveness risk is simply to keep the carbon price low enough that such losses remain within acceptable bounds. This, naturally, limits the amount of domestic emissions reductions that will be achieved as well. The international dimension of GHG emissions cap can only be managed by somehow engaging the participation of all countries that compete or have the potential to compete with our key industries. Until that issue is resolved, ambitions to make significant reductions through any domestic cap-and-trade program will be thwarted. At the same time, this concern also implies that any domestic cap-and-trade program that *is* implemented in advance of internationally coordinated efforts should be designed with clearly defined permit price caps.

It is worth returning to the positive side of the international dimension, which is that cost-effective emissions reductions can exist anywhere in the globe. Without an international set of caps, the only way for a domestic cap program to tap into these opportunities would be through a project-by-project "offsets" provision in the domestic program. The Clean Development Mechanism (CDM) was established under the Kyoto Protocol to offer nations with caps under the Kyoto Protocol to obtain such offsets from nations without caps under the Kyoto Protocol. The experience with the CDM so far has been mixed, at best. Any scheme to allow individual projects to be approved by the regulators to offset emissions under a cap will be fraught with transaction costs and other types of hurdles that either raise the cost of the project above its actual technological cost, or actually hinder the ability to access certain types of control opportunities. These concerns have been made widely documented in the first few years of the CDM. Although some of the issues may disappear or be eliminated with more time, it is clear than a projects-based approach does not

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[12] Mercury risks to US residents are created largely by mercury emissions in aggregate around the globe, but leakage of mercury emissions under a cap on US electric generating emissions is not a concern because (a) the costs of achieving a given degree of mercury emissions reduction are not nearly as high as comparable percentage reductions of CO_2, and (b) these costs will be imposed only on coal-fired generators, which are not themselves subject to international competitiveness changes that create leakage of the direct emitters.

generate the degree of opportunities to reduce near-term costs of compliance that would materialize if all the international emissions sources were under the cap themselves.

Another point is being made frequently in the emerging reviews of the CDM experience, which is the extent to which this mechanism serves as a conduit to shift large amounts of wealth to a few individual parties in developing countries, to achieve reductions in GHGs that could actually be required at minimal cost by the developing countries.[13] In essence, the bureaucratic delays of approving CDM projects have created a shortage of supply of such credits to meet the large demand for them in the EU and other nations seeking to purchase such credits to meet their Kyoto limits. This shortage gives the few suppliers that have successfully emerged from the CDM certification pipeline with saleable credits in time for the first commitment period (i.e., 2008-2012) to be able to sell those credits at a premium well above their cost, and very close to the much higher cost of emissions reductions within the capped countries.[14] Although these CDM projects do reduce the global cost of meeting the developed countries' targets, only a very small fraction of those cost savings are being experienced by the companies (or governments) that are facing the caps. All of the cost savings are being translated into wealth transfers to the project owners and to the lawyers and other parties that are facilitating the contracts.

AVOIDANCE OF CAP-AND-TRADE IS A WORSE POLICY RESPONSE

The challenges of designing a GHG cap-and-trade system that has the promise of being functional and fair may seem daunting. As I have tried to explain above, there are reasonable approaches that will work, albeit with limitations on how much can be done before there is any internationally coordinated policy. Application of these policy options could result in an efficient and streamlined cap-and-trade program, but it would have very little resemblance to the widely touted Federal SO_2 and NOx cap-and-trade programs.

The policy difficulty lies in the persistent effort to force the design that made sense for utility SO_2 and NO_x emissions onto the very different (and more complex) situation for economy-wide, multi-specied GHG emissions. Another part of the problem, in my opinion, lies in the persistent and mistaken belief that the only market-based approach available is cap-and-trade. In fact, emissions fees are technically the more appropriate policy tool for the GHG situation. Efforts to design a program that is cap-and-trade by name, but has all the important merits of an emissions fee lead to some of the apparent differences (and complexities).

Unfortunately, the response of many in the policy community who are facing this complex discussion about the pros and cons of extremely different types of cap-and-trade approaches appear to be opting out of the effort altogether. Many are suggesting that we

[13] M. Wara, "Measuring the Clean Development Mechanism's Performance and Potential," Working Paper #56, Program on Energy and Sustainable Development, Stanford University, July 2006. available at http://iis-db.stanford.edu/pubs/21211/Wara_CDM.pdf.

[14] Capoor, K. and P. Ambrosi, 2006, "State and Trends of the Carbon Market 2006," report prepared for World Bank and International Emissions Trading Association, Washington, D.C., (May), available at http://carbonfinance.org/docs/StateoftheCarbonMarket2006.pdf.

should take a number of initial small steps in the direction of emissions reductions while waiting until the time is ripe for a true cap-and-trade program. This approach can only worsen the situation, as it amounts to an incremental implementation of a full scale command-and-control approach. Each individual policy measure will usurp the flexibility of decisions that are offered by market-based approaches like cap-and-trade. Once the flexibility is removed, it cannot be entirely regained if and when a cap-and-trade program is later implemented – too many compliance-related investments will have become sunk costs in the interim. Further, each of these incremental policies will result in not just higher, but hidden costs, as regulatory approaches are good at doing. The net effect may be emissions reductions starting in advance of the potential implementation of a sound market-based approach. However, the costs to our economy, and the losses in potential incremental innovations that are associated with market-based approaches, will be large.

One insight about the magnitude of difference in the efficiency of cap-and-trade compared to some of the leading regulatory alternatives comes from analyses I and my colleagues have done regarding renewable portfolio standards (RPS). In a recent analysis for Australia's National Generators Forum, CRA International modeled the costs and emissions reductions that would be obtained from caps of various stringencies, and we also modeled several technology mandates, one of which as a national RPS of about 10%.[15] This analysis found that the 10% RPS would produce the emissions reductions consistent with a CO_2 price of just above about $AU10/ton, but at the cost of a carbon policy that would reduce emissions by about four times more. We also found that the same CO_2 emissions reductions that the RPS would create could be achieved at about one-third of the cost if achieved via a pure cap-and-trade policy than via the RPS. We have performed similar analyses more informally for a national RPS standard in the U.S., with even more striking results. In our unpublished U.S. analysis, we estimated the cost and CO_2 emissions under a national RPS of 2.5% in 2012 increasing to 10% by 2024 (following a standard much like that of the Bingaman RPS Proposal in 2003.) We then estimated the cost of meeting a CO_2 emissions target equal to the CO_2 emissions levels achieved by the national RPS. The same emissions reductions under the RPS approach cost four times as much as if they were accomplished with a utility-wide cap. The savings would be greater still if the cap had been imposed economy wide rather than just on utility sources.

CONCLUSION

My entire testimony has been focused on the specific question of this hearing, how to design an effective cap-and-trade program for GHGs. My key point, which I started with, is that cap-and-trade programs can be very different in their design, and the design should be tailored to the specific nature of the emissions control situation. This leads to a very different design than that of the SO_2 and NO_x programs, which are viewed by many as the role model for GHGs. The EU ETS has been designed to follow much of the SO_2 model, and some (but not all) of its difficulties can be attributed to that fact. The US can and should do better with US-made market-based approaches for addressing GHGs.

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[15] A Smith, G Thorpe, D Chattopadhyay, "Analysis of Greenhouse Gas Policies for the Australian Electricity Sector ", report to the National Generators Forum, September 2006. (The RPS is labeled "MRET" in this report.)

With those central points in mind, I want to close by noting that even a highly effective and efficient market-based approach for GHGs will have a serious limitation that should not be forgotten. An adequate national climate policy must consist of more than a system of efficient GHG controls. Actual stabilization of climate change risks will require that GHGs be reduced to nearly zero levels. Although this goal may be possible to achieve at some point in the later part of this century, it can only be done through truly revolutionary technological progress and the resulting changes in the structure of how our energy systems.

Hoffert *et al.* report that "the most effective way to reduce CO_2 emissions with economic growth and equity is to develop revolutionary changes in the technology of energy production, distribution, storage and conversion."[16] They identify an entire portfolio of technologies requiring intensive R&D, suggesting that the solution will lie in achieving advances in many categories of research. They conclude that developing a sufficient supply of technologies to enable near-zero carbon intensity on a global scale will require basic science and fundamental breakthroughs in multiple disciplines. Therefore, Herculean technological improvements beyond those that are already projected and accounted for in cost models appear to be the only hope for achieving meaningful reduction of climate change risks. By inference, no cap-and-trade system should be placed into law that does not simultaneously incorporate specific provisions that directly support a substantially enhanced focus on energy technology R&D.

Placing a price on carbon emissions, as a cap-and-trade program would do, would affect the pattern of private sector R&D. However, this so-called "induced-innovation effect" would be small. Economic analysis shows that market forces produce a less than socially optimal quantity of R&D. Once a private sector innovator demonstrates the feasibility and profitability of a new technology, competitors are likely to imitate it. Copycats can escape the high fixed costs required to make the original discovery. Therefore, they may gain market share by undercutting the innovator's prices. In that case, the initial developer may fail to realize much financial gain. Foreseeing this competitive outcome, firms avoid investment in many R&D projects that, at the level of society as a whole, would yield net benefits.[17]

The task of developing new carbon-free energy sources is likely to be especially incompatible with the private sector's incentives. With no large emissions-free energy sources lying just over the technological horizon, successful innovation in this area will require unusually high risks and long lead times. As Hoffert *et al.* pointed out, developing the needed technologies will entail breakthroughs in basic science, placing much of the most essential R&D results beyond the boundaries of patent protection. These are precisely the conditions under which for-profit firms are least likely to rely on R&D as an

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[16] M. I. Hoffert *et al.*, "Advanced Technology Paths to Global Climate Stability: Energy for a Greenhouse Planet" *Science*, Vol. 298, Nov.1, 2002, p. 981.

[17] These points are developed in a more rigorous fashion in W. D. Montgomery and Anne E. Smith "Price, Quantity and Technology Strategies for Climate Change Policy," in M. Schlesinger *et al* (eds.) *Human-Induced Climate Change: An Interdisciplinary Assessment*, Cambridge University Press, forthcoming 2007.

approach to problem-solving. Thus, greenhouse gas caps on their own would insufficiently increase private sector R&D directed toward technological solutions to abatement.[18]

Market-based policies can very effectively stimulate incremental innovation and deployment into the market place of emerging new technologies. They cannot, however, stimulate the kinds of technological progress necessary to enable meaningful emissions reductions later on. Realistically, then, government must play an important role in creating the correct private sector incentives for climate-related R&D, as well as in providing direct funding to support such activity. This role must be built into any cap-and-trade policy, in order to avoid establishing an emissions policy that cannot fulfill expectations, and to avoid wasteful diversion of key resources for the requisite forms of R&D.

Merely establishing cap and trade cannot meet the crucially important need for enhanced emphasis on basic research rather than additional subsidies for specific technologies that are already far along in the development process. It also does not clearly define government's role or an appropriate division of labor or risk between the public and private sectors in the development of new technologies, whether as commercialization and incremental improvement of existing low-carbon technologies, or R&D for new, breakthrough technologies. Creating an effective R&D program will not be easy, but it ultimately has to happen if climate risks are to be reduced. The difficult decisions are how much to spend now, and how to design programs to stimulate R&D that avoid mistakes of the past.

In conclusion, the current policy debate about how to impose near-term controls through cap-and-trade programs is encouraging policy makers to neglect much more important, more urgently needed actions for reducing climate change risks. The top priority for climate change policy should be a greatly expanded government-funded research and development (R&D) program, along with concerted efforts to reduce barriers to technology transfer to key developing countries. Neither of these will be easy to accomplish effectively, yet they are receiving minimal attention by policy makers.

[18] Further, the "safety valve" in the Proposed Policy is designed to provide assurance that the price of emission allowances will not reach economically unsustainable levels. But that causes the carbon prices to be set at a level far too low to provide an adequate incentive for private investors to develop radically new technologies. Removal of the safety valve provision also is not an option, as a hard cap would impose a degree of market risk that would be unsustainable politically.